Automatiza tion of Technological Processes in Gasification of Fuel and Glass Melting

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AUTOMATIC CONTROL OF FUEL GASIFICATION AND GLASSMELTING

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(From the experience of the Gomel' Glass Plant)

During the years of the postwar Stalin Five-Year Plan, the status of the glass industry abruptly changed. The design of glass-melting tank furnaces and machine channels were greatly improved; layer feeding of the charge and cullet into the tank furnace was introduced; high speed pulling of glass sheets has been successfully adopted; a number of laborious processes have been mechanized, including the equalization of the sulfate content, the transfer of glass plates from the VVS machine to the cutting table, the cutting of glass plates, etc.

All of these measures have played an important part in the intensification of processes of glass melting and working of glass, and in the improvement of the quality of the finished product.

Together with these, the technological and thermotechnical utilization of the basic equipment and units of glass-melting plants has become more intense; in order to provide for continous operation, thorough regulation and constant control is required. This problem has been successfully solved by the introduction of automatic control of the basic processes at gas plants, which serve the tanks, machines, and integrated shops.

During 1949-1950 at the Gomel' Glass Plant imeni Stalin, automatic controls of basic processes and of production were introduced, the principles of which are presented in this paper.

The consumption of generator gas at the plant was greatly increased in 1949 because of the conversion of the furnaces of the ceramic shop to gas firing and also because the increased gas consumption by the tanks as a result of the intensification of the glass-melting process.

It was decided to resort to automatic control of fuel gasification as a substantial means of increasing generator gas output. As is known, for normal gas generation a definite quantity of steam must be added to the airblast which is fed under the grates of the gas generator because with the air blast alone the calorific value of the gas if reduced (because of the high percentage of nitrogen in the gas); also, the developing high temperatures in the gasification zone melt the ash, which leads unavoidably to a poor distribution of blast and to a considerable loss of fuel in the drop. The introduction of excessive quantities of steam causes a temperature drop in the gasification zone, reduction in the quality of gas, and a drop in the productivity of the gas generator.

Thus the automatic regulation of the temperature of a steam-air blast, i.e., saturation of the mixture with steam, should improve the performance of gas generators.

Before the introduction of automatic control, the average performance of individual gas generators was characterized by the following data: the take-off from one square meter of the generator grate, 240 kilograms per hour (or 40 tons of peat per day); the gas yield from one kilogram of peat, 1.2 cubic meters; the caloricity of the gas (QP_h) 1,280-1,300 calories per cubic meter; the output, 2,600,000 calories per hour.

After the gas plant adopted automatic control of the basic processes there was a considerable improvement in fuel gasification. Automatic temperature control of the steam-air mixture became nearly perfect, the variations not exceeding ± 0.4 - 0.5 degrees for given conditions through the interval of 40-60 degrees. The uniformity of the steam-air blast at the lower optimum temperatures of the mixture assured a substantial yield of high grade gas with a CO_2 content of 7.5 - 8 percent.

Automatic temperature control of the steam-air mixture, in conjunction with automatic control of gas pressure in the receiver of wet and dry gas and with the simultaneous improvement of technological conditions in other sections of the gas plant, improved considerably the gasification processes and increased the productivity of the gas plant as a whole.

After the indicated measures were carried out, the individual gas generators were characterized by the following data: take-off from one square meter of the generator grate, 360 kilograms per hour or 60 tons; the caloricity of gas (QP_h), 1,330 calories per cubic meter; the output, 4,270,000 calories per hour.

Almost simultaneously with the introduction of automatic temperature control of the steam-air mixture (end of 1949 and beginning of 1950), equipment was set up at the plant for automatic pressure control in receivers of scrubbed gas.

Plant practice has conclusively demonstrated that the stabilization of pressures in the receiver of scrubbed gas sharply improved the possibility of maintaining given temperatures in the tank furnaces and machine channels. Those automatic controls maintain a steady gas pressure within ± 1 millimeter of water for given conditions within the range of ± 80 millimeters of water. The automatic control of gas pressure in the receiver of scrubbed (raw) gas is in close interaction with automatic control of pressure in the collector of scrubbed gas and assures a steady pressure within ± 1 millimeter of water for a given pressure of + 5 millimeters. In addition to the above mentioned advantages, steady pressure in the receiver of raw gas provides complete safety for gas plant operation.

It is necessary to note some of the disadvantages in the normal functioning of automatic controls. These include unsatisfactory design of the valved regulators. After one to two months of operation, the valves begin to turn with difficulty. The plant has developed new valved regulators which have already been produced and are now installed in inlet valves. The design of the new regulator is shown in Figure 1.

Normal automatic temperature control of the mixture is possible only if there is a sufficient and uninterrupted feed of air.

In the first half of last year, when modernization of the first section and cold repair on the second section were carried out and the gas generator stations operated under a work load of 50-60 percent, the quantity of steam obtained from the steam boilers and from the low pressure boiler in the ceramic department was sufficient to maintain a steam-air blast.

With bath sections in operation and also with the conversion of sand-drying drums in the integal department and of the new furnace in the ceramic department to gas, the demand for gas increased considerably (22,000 cubic meters per hour).

At present the gas plant operates continually under a steam limitation, and the automatic temperature control of the steam air mixture is, therefore, less effective.

Due to the increased output of the gas plant, the air and gas blowers also operate under a limitation, this has an adverse effect on automatic control of gas pressure in the receivers of raw and scrubbed gas because the regulators are always in the maximum open position.

The introduction of automatic control at gas generating stations contributed a great deal to the success of automatic control of gas-to-air ratio in tank furnaces.

During the first quarter of 1950, automatic control of the gas-to-air ratio was set up in section No 2. Moreover, the problem of air intake was solved in an original manner. A force fan was set up in the area of the 7th burner; the intake pipe was installed on the crown of the tank furnace, and the pressure mains were installed along the principal crown.

Such a design allowed no cold air to pass under the generator, but only air heated to 50-60 degrees. The importance of automatic control of the gas-to-air ratio is extremely great.

Before the introduction of automatic control, a decrease or increase in gas consumption in a tank furnace was not accompanied by a corresponding decrease or increase of regenerator air supply.

At the best, only a rule-of-thumb control was exercised by the glass melter. Such control of the gas-to-air ratio lead inevitably to overheating of fuel and frequent fluctuations of temperatures along the axis of the tank furnace. When sulfate-soda or sulfate charge was melted, an incorrect gas-air ratio affected the glass melting processes adversely to a substantial degree, causing periodic discoloration of the glass melt by the gas or an excess of free gall.

All the enumerated disadvantages are almost completely eliminated through automatic control of the gas-to-air ratio. The gas-to-air ratio, which is determined by analysis of flue gases and established by the feeder, is strictly maintained.

Forced blast assumes special importance during the pre-repair period, when the nozzles of the regenerator are badly clogged and a considerable insufficiency of air is experienced.

During 1949-1950 a number of measures were undertaken at the plant with the aim of reducing the specific consumption of fuel. There is no doubt that automatic control of the air-to-gas ratio aided in the improvement of this index; this is evident from the following data: the consumption of gas per ton of the finished product was 3,302 cubic meters in 1949, in 1950 it was 3,149 cubic meters. The specific fuel consumption per ton of finished product was 1,183 kilograms and 1,174 kilograms respectively.

During the operation of the automatic control of the gas-to-air ratio, the following defects were discovered: imperfection in the design of the valved regulator; small delivery of the specified blower; incorrect installation of the intake assembly (motor with blower) in the area of the 7th burners; noise made by the operation of the equipment was of considerable inconvenience to the operators on the machine channel.

The aforementioned defects are being eliminated by the plant.

When installing automatic controls in section No 1, the motor with the blower is placed under the tank furnace. Warm air is taken in under the bottom of the tank furnace and is then heated further in the air channel above the bottom of the furnace. A similar modernization of the automatic controls for the gas-to-air ratio was carried out in section No 2.

The maintenance of constant pressure in the recess of the tank furnace regulates the glass melting processes and promotes stabilization of the temperatures in the cooling section of the tank furnace in the center of the working channel.

In the second section of the glass works, automatic regulation of pressure in the tank furnace was set up in the 1st quarter, and in the first section, during September and October 1950.

In the first half-year, due to prolonged shutdowns of both tank furnaces for modernization and cold repair, it was not possible to test the differential manometer which was made by the Automatics Laboratory of the Glass Institute. [A differential manometer with isodromic relay has been set up in the 2nd section of the Gusevo Plant (Editor).]

As per the indicated cause in the installation of automatic pressure controls on the tank furnace, a very simple arrangement was used, i.e., the impulse taken from the main slide valve of the smokestack. In addition, a given constant vacuum is automatically maintained at the smoke stack of the tank furnace.

The effect of the constancy of the glass level in a tank furnace upon the production capacity of VVS machines and qualitative indexes of manufactured glass is irrefutable.

Practical operation at the plant has shown that the fluctuation of the glass melt level between the limits of 3-5 millimeters retards by a few days the production of first class glass about 10-15 percent.

After installing the thin layer feeders of the charge and cullet into the tank furnace, fluctuations of glass melt level were considerably reduced, but nevertheless were observed within the range of one millimeter.

According to the proposal of the chief of the Heat Treatment Section, Comrade Shumskiy, and former chief of the Electric Department, Comrade Rivin, the process of feeding the charge and cullet was mechanized by means of the synchronization of the action of the level gauge glass melt with the motor of thin layer feeder by means of a Kaminskiy system resistance and a contact millivoltmeter. With the introduction of this unit the automatic fluctuation of the level of glass melt does not exceed 0.5 millimeter.

Last year at the Plant the design of the feeder was perfected to a great degree; (a) the thin layer feeder was replaced by a bank feeder, (b) one feeder was changed into three units (in section No 1) and into 5 units (in section 2). The last feature makes possible flexible operation of the feeders and timely repair of one of the units without disrupting the charging or causing fluctuation of the level of glass melt.

The automatic control panel board of a glass melting furnace is shown in Figure 2.

In mechanizing the processes at the plant, the OSKB of the Main Administration of Industrial Glass [Glavtekhsteklo] helped considerably in the period of installation as well as in the process of getting the automatic processes into operation.

The collective of the Gomel' Glass Plant imeni Stalin set as its goal for 1951 the completion of the installation of automatic controls in tank furnaces and making basic processes in the related shops automatic.

The plant is in need of assistance in securing its required machines and equipment and in getting skilled personnel for installing and the operating the automatic control equipment.

There is no doubt that the introduction of automatic control of basic technological processes will raise the technical culture of glass melting plants and will promote further improvement in the qualitative and quantitative indexes of their operation.